

ELECTROMAGNETIC COMPATIBILITY AND SAFETY

Master Degree in Communications & Data Security Engineering (ISDC)

Master Degree in Information Technologies Engineering for Communications and Health (ITICS)



February 27, 2023

EMCS Master Course, Introduction - Prof. A. Buono - A.A. 2022/2023



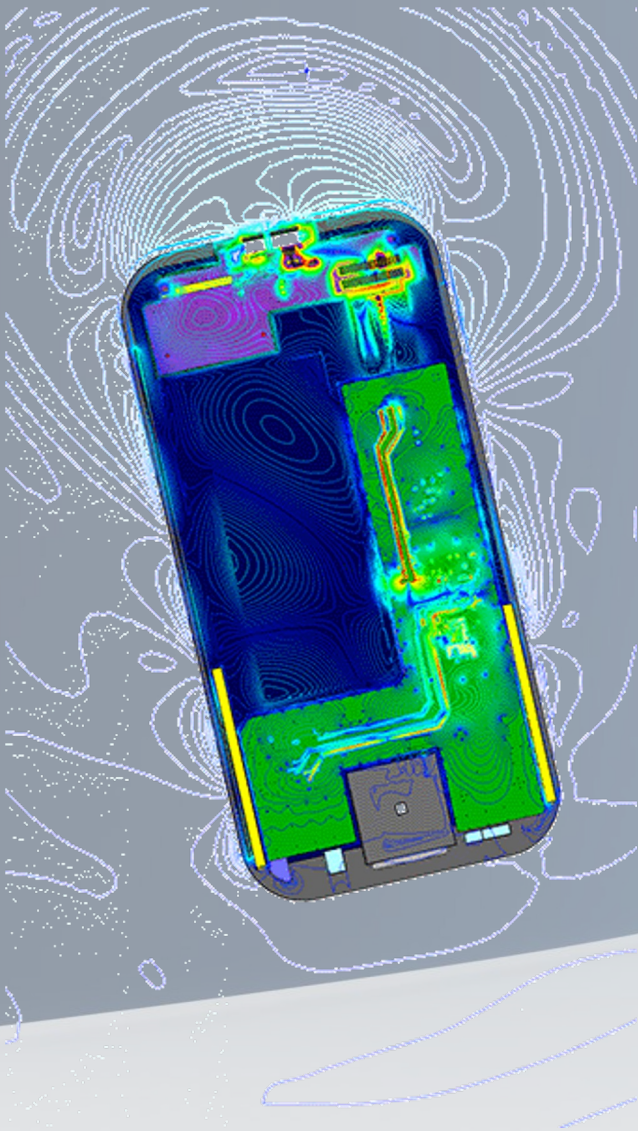
INTRODUCTION

Table of Contents:

- ✓ **Overview**
- ✓ **Organization**
- ✓ **Audience**
- ✓ **Basics**



INTRODUCTION: OVERVIEW



Electromagnetic Compatibility

«EMC deals with the study of generation, transmission and reception of **unintended EM energy** with reference to the **unwanted effects** that it may have with the aim of ensure proper working of the nearby electronic devices operating within the same environment.»

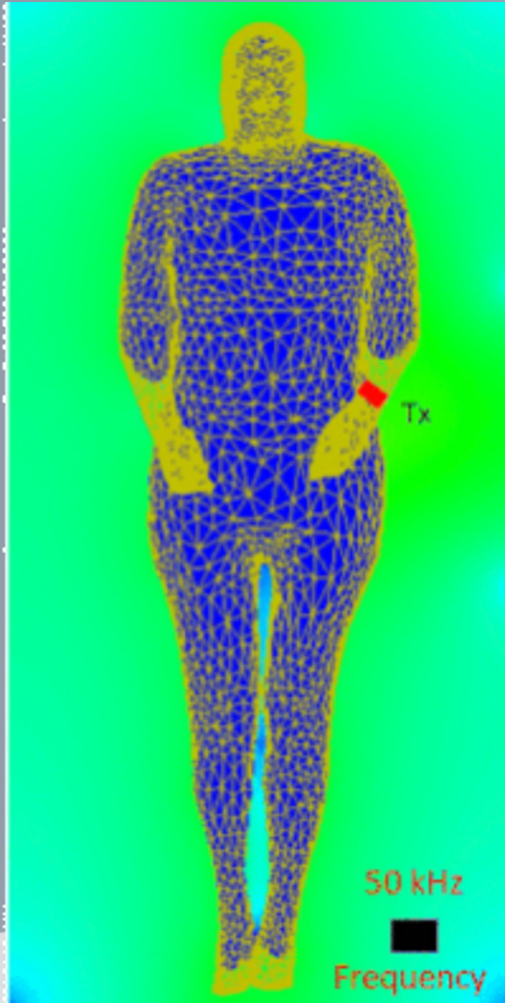
INTRODUCTION: OVERVIEW



Electromagnetic Security

«**Security** refers to practices and countermeasures adopted **to prevent intended malicious operations and to protect devices and people** from such events.»

INTRODUCTION: OVERVIEW



Electromagnetic Safety

«**Safety** refers to practices and behaviors adopted **to protect devices and people** from **unintended events** that may be potentially harmful.»

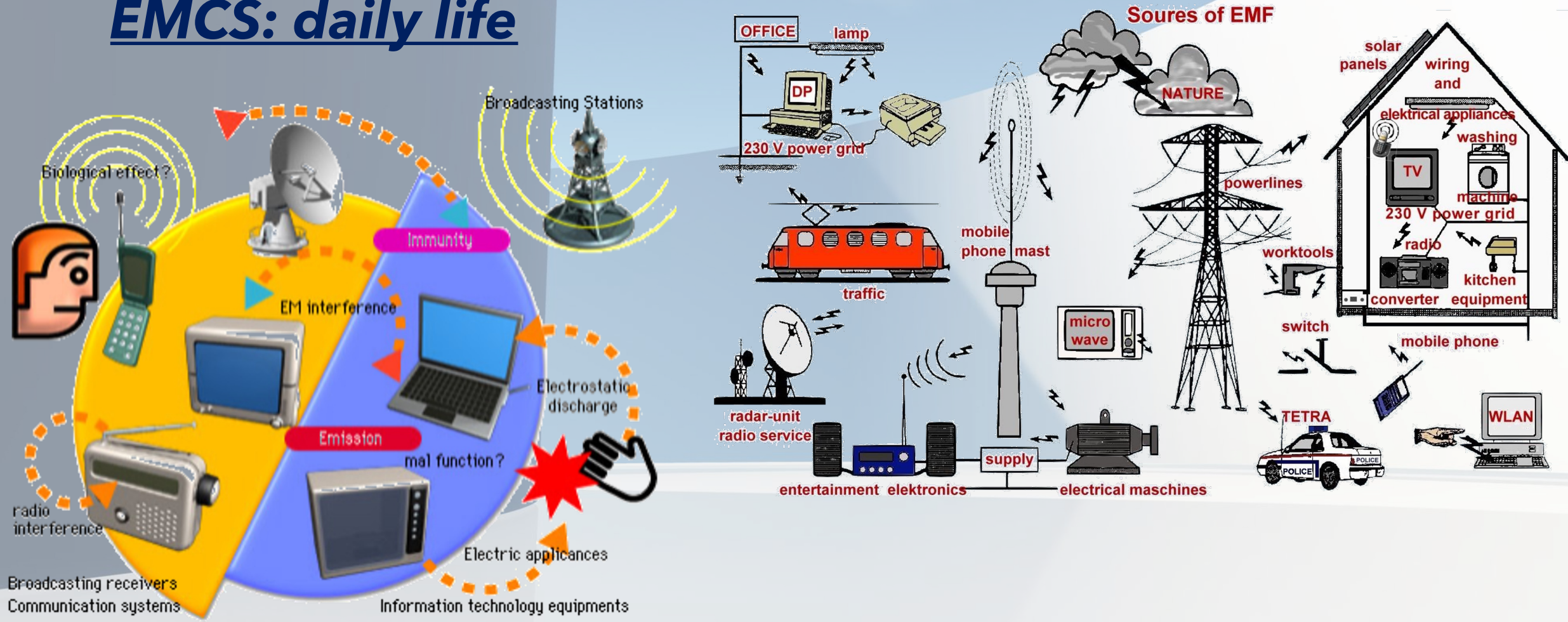
INTRODUCTION: OVERVIEW

EMCS: daily life



INTRODUCTION: OVERVIEW

EMCS: daily life



EMCS: Stories of failure

The crew of *USS Forrestal* (CVA 59) extinguishes the remaining fires on the flight deck off the coast of Vietnam, 29 July 1967. In the foreground are the remains of an F-4B *Phantom*, behind which can be seen the burned hulk of a second *Phantom*. One hundred thirty-four crew died in this fire, the worst aboard a U.S. Navy aircraft carrier. U.S. Navy photograph.

1967



Phoenix Weather

7:30 a.m. 70 to 80 per cent chance of rain today. Tuesday's high near 80. Wednesday's high near 80. Thursday's high near 80. Friday's high near 80. Saturday's high near 80. Sunday's high near 80.

7th Year, No. 74

TELEPHONE: 278-0886

Phoenix, Arizona, Sunday, July 30, 1967

BUILDING Today's Chronicle

How views from both buildings and city skyline can be seen from the new building. See the daily times.

Twenty-Five Cents

Arizona Republic

Forrestal Informs Claim \$16

Find Riot Roots, Commission Told

WASHINGTON (AP)—President Johnson personally ordered his own commission of civil disorders to check policies on riotous marching and get the truth about the estimated rank of demonstrators now and how to prevent them.

LBJ Tells SBA To Issue Loans For Riot Repair

WASHINGTON (AP)—Johnson yesterday ordered his own commission of civil disorders to check policies on riotous marching and get the truth about the estimated rank of demonstrators now and how to prevent them.

President Johnson, who has urged his own commission of civil disorders to check policies on riotous marching and get the truth about the estimated rank of demonstrators now and how to prevent them.

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Guard Is Urged To Retrain Men For Riot Control

WASHINGTON (AP)—The National Guard Association of the United States called for urgent retraining in its own training to help control riots.

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Many More Missing: 29 Planes Lost

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INTRODUCTION: OVERVIEW

EMCS: Stories of failure



1981



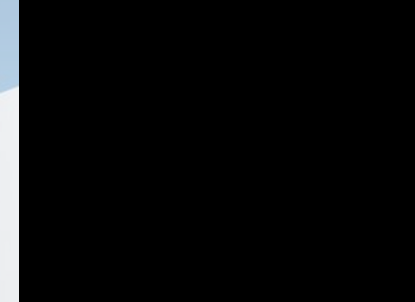
INTRODUCTION: OVERVIEW

EMCS: Stories of failure

1982



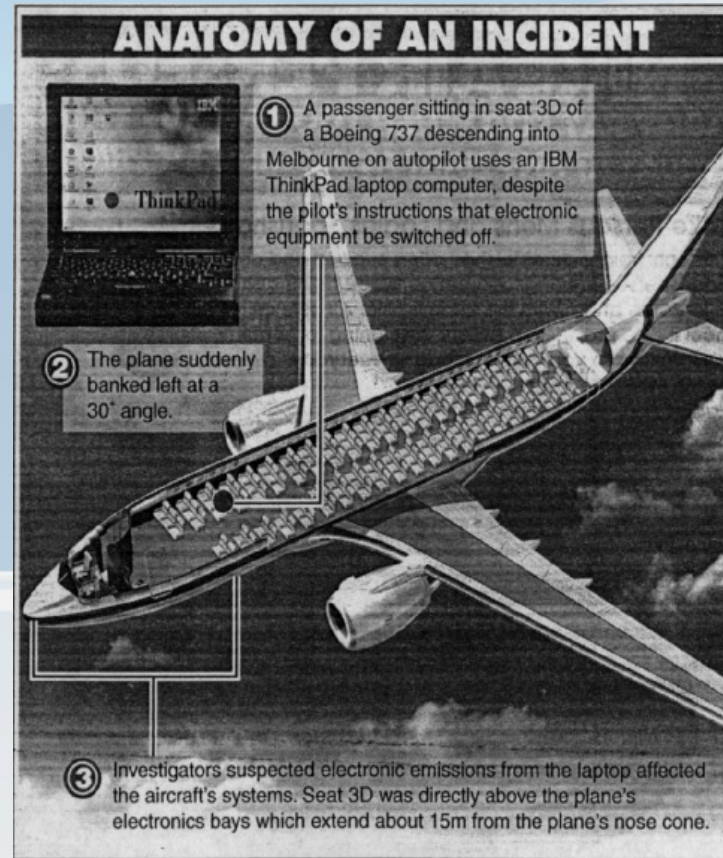
picture: The Weekend Australian 21-22 June 2003



INTRODUCTION: OVERVIEW

EMCS: Stories of failure

1998



THE Boeing 737 was making a normal descent into Melbourne. The plane was on autopilot and the lateral navigation system was working.

In seat 3D, a passenger was hard at work on an IBM Thinkpad laptop computer.

About 60km north of Melbourne the big plane lurched to the left, banking about 30deg.

But no one had touched any of the plane's controls and the movement certainly wasn't part of the autopilot program.

The passenger in 3D may have noticed the movement but remained blissfully unaware of the crisis happening on the other side of the cabin door and equally unaware of what is believed to be his role in it.

"It is suspected that electronic emission from the laptop impinged on the aircraft systems," an air safety report into the incident concluded.

Experts believe that one

By **PETER LALOR**
and **ADAM HARVEY**

day a small personal electronic device (PED) such as a laptop, mobile phone, CD player or games computer is going to cause as much carnage on an aircraft as a terrorist's bomb.

Tiny electronic signals from these devices can be picked up by a plane's automatic navigation systems, sending them haywire.

The personal devices, like most modern electrical equipment, operate on a binary system which sees small electric currents switching at incredibly fast rates through the system.

The switch goes on if it receives a message of between two to five volts or stops if it gets nothing.

In modern computers this switching process occurs at a rate of hundreds of millions a second and creates electro-magnetic radiation in its immediate area.

A mobile phone communicates by electro-

Page 42 The Sunday Mail October 4, 1998

EMCS: Stories of failure

2023



About potential magnetic interference with medical devices

Many consumer-electronic devices contain magnets or components and radios that emit electromagnetic fields.

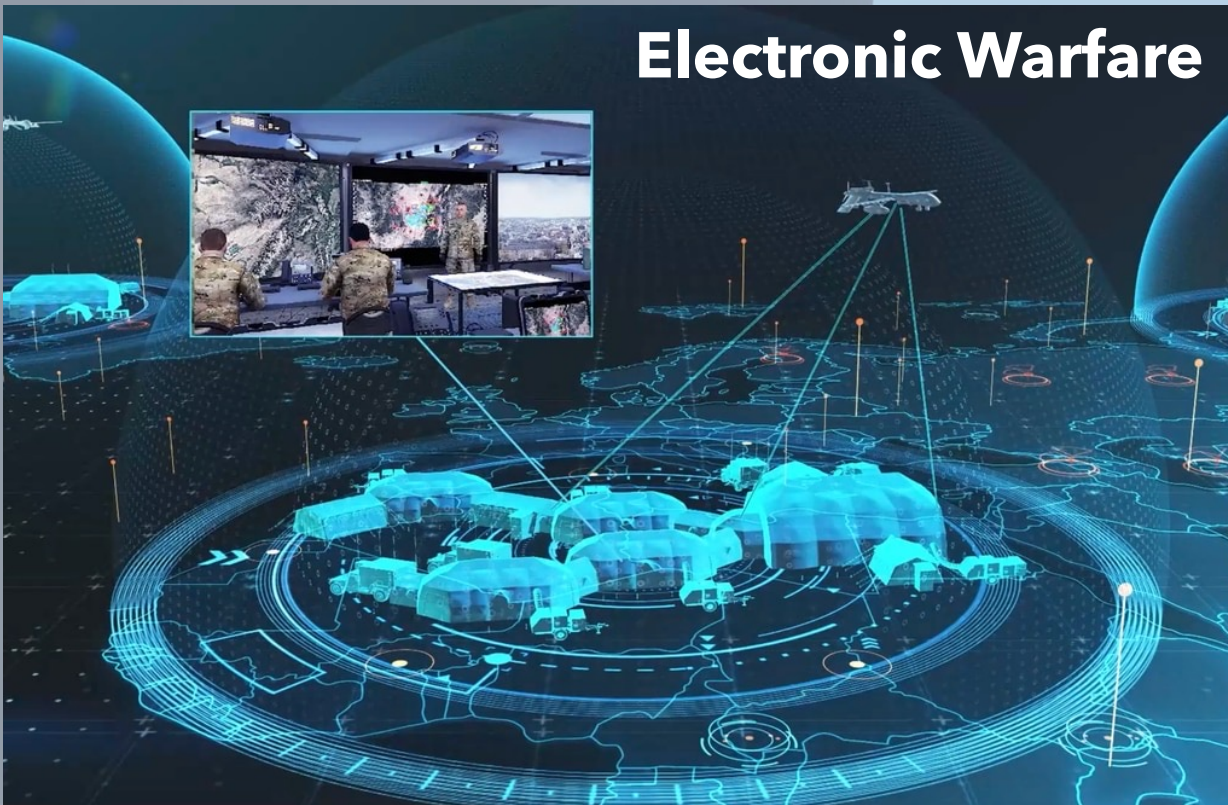
Magnetic interference and medical devices

Under certain conditions, magnets and electromagnetic fields might interfere with medical devices. For example, implanted pacemakers and defibrillators might contain sensors that respond to magnets and radios when in close contact. To avoid any potential interactions with these types of medical devices, keep your Apple product a safe distance away from your medical device (more than 6 inches / 15 cm apart or more than 12 inches / 30 cm apart if wirelessly charging). Consult with your physician and your medical-device manufacturer for specific guidelines.

If you suspect that your Apple product is interfering with your medical device, stop using your Apple product and consult your physician and your medical-device manufacturer.

INTRODUCTION: OVERVIEW

EMCS: Stories of failure



- Tsushima battle, Russia vs Japan war (1905)



- WWII: Battle of beams (W. Churchill, 1940)



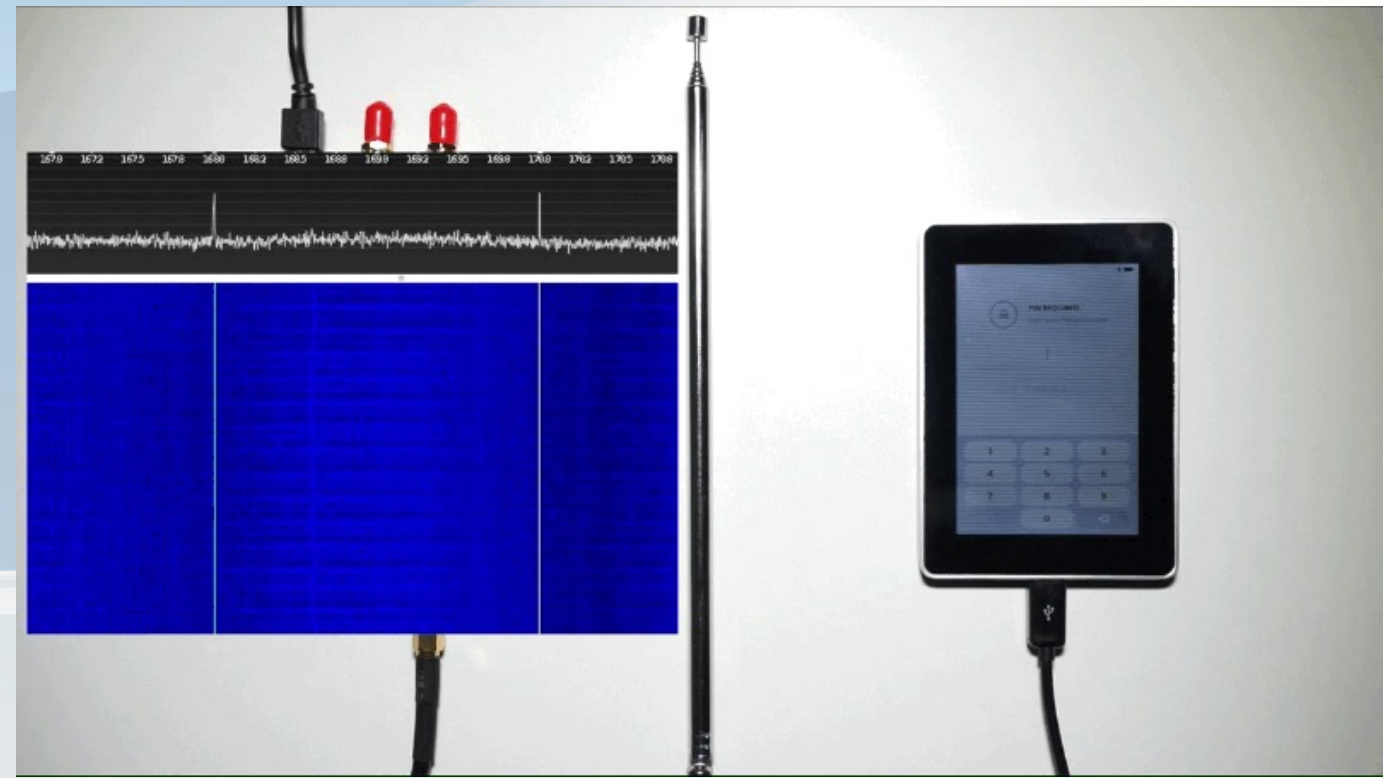
INTRODUCTION: OVERVIEW

EMCS: Stories of failure



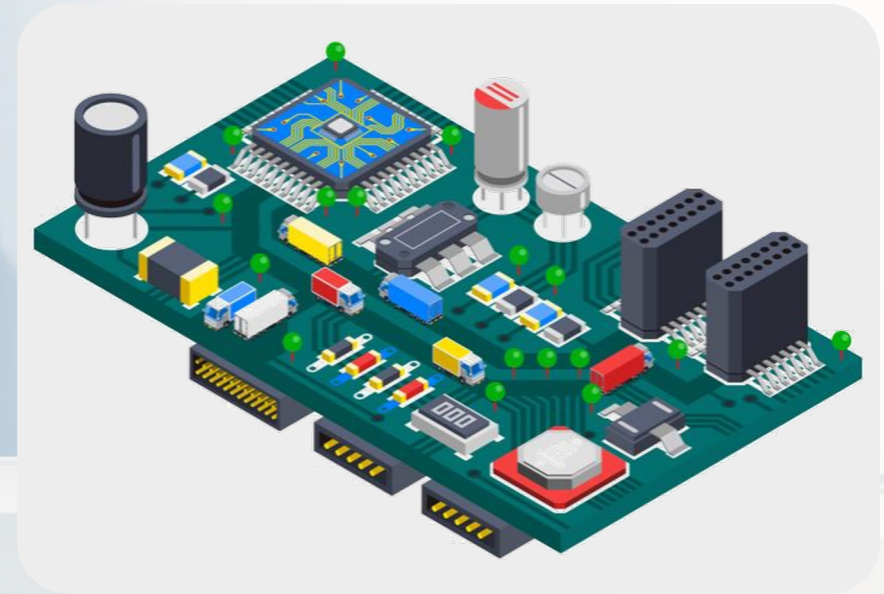
Jamming 

Side-channel EM attacks



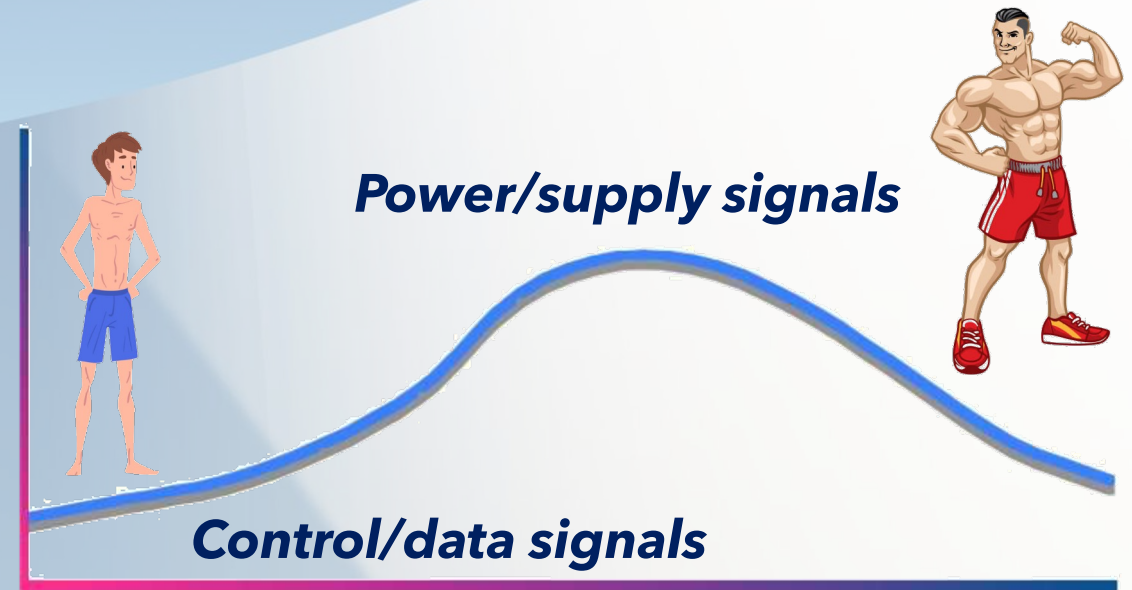
INTRODUCTION: OVERVIEW

EMCS: Environments



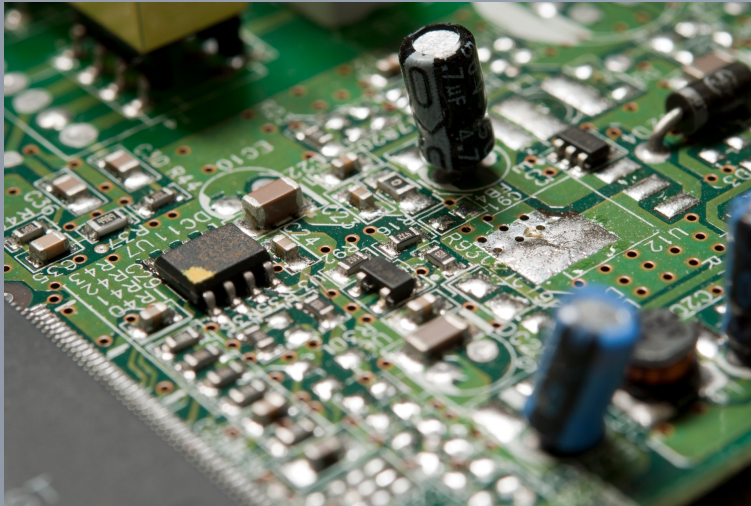
INTRODUCTION: OVERVIEW

Why EMCS?

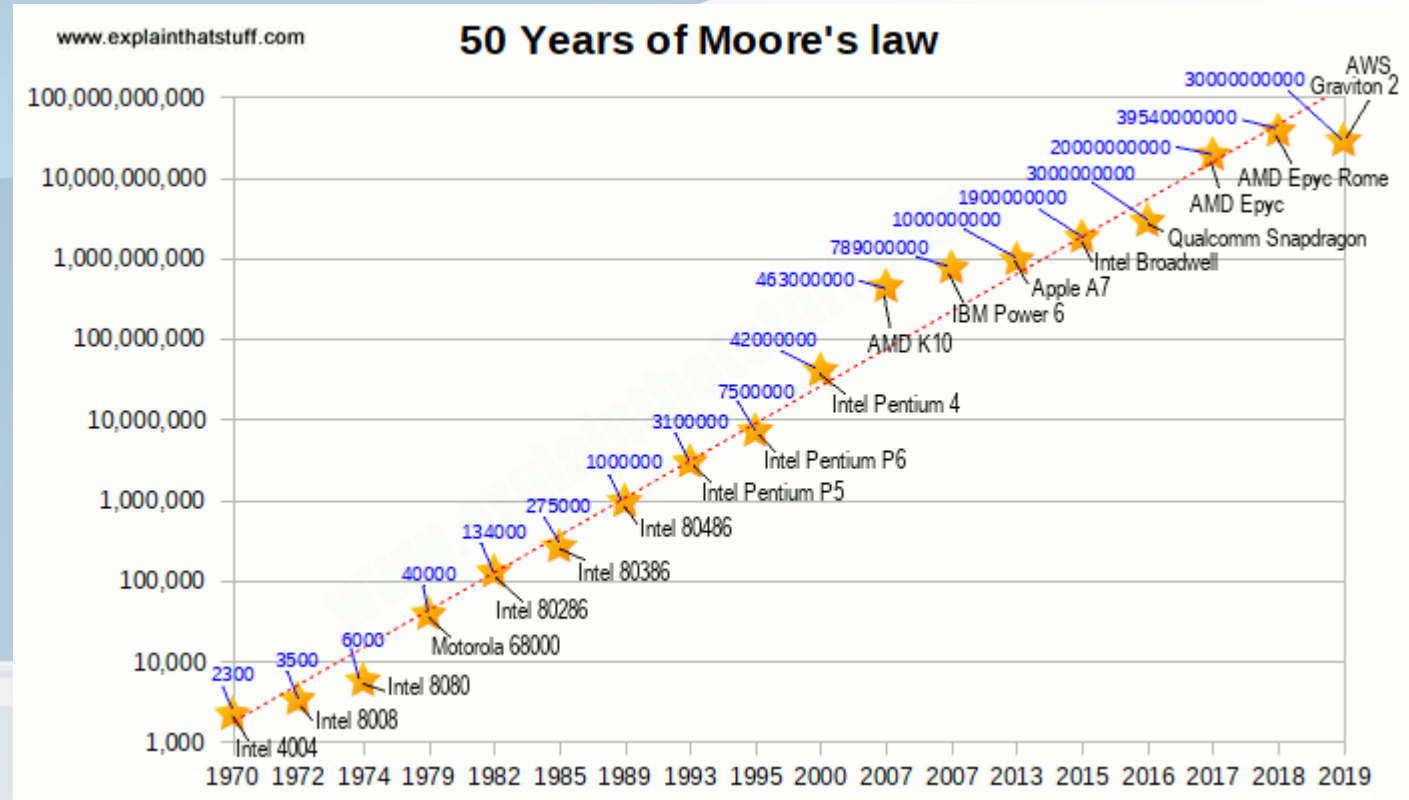


INTRODUCTION: OVERVIEW

Why EMCS?

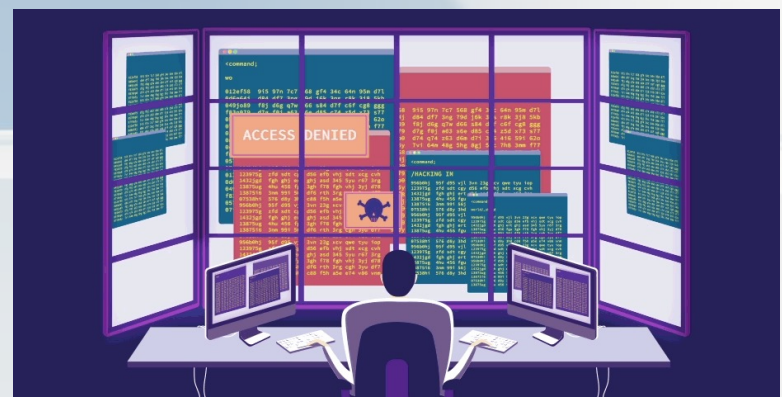
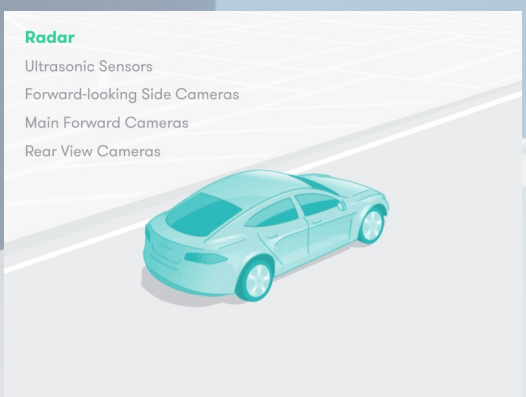
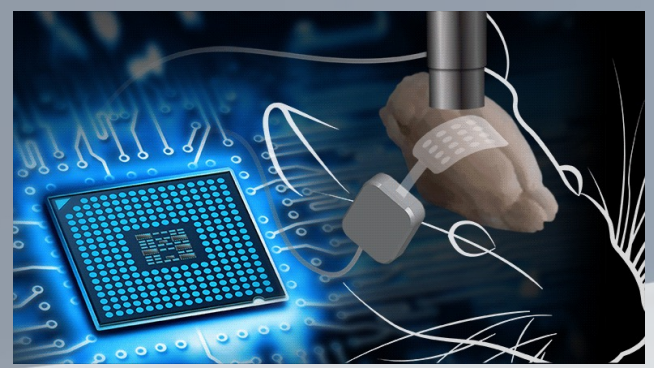
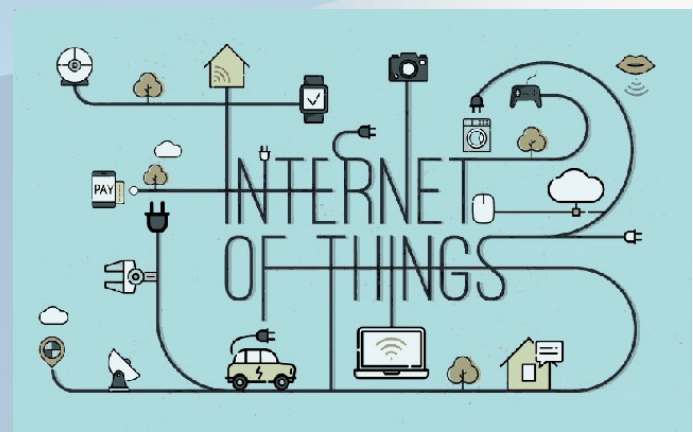
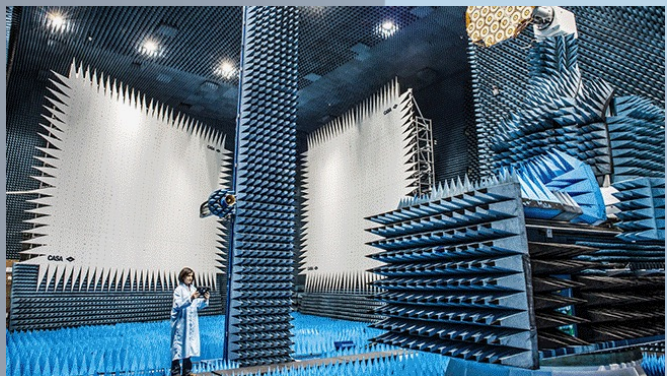
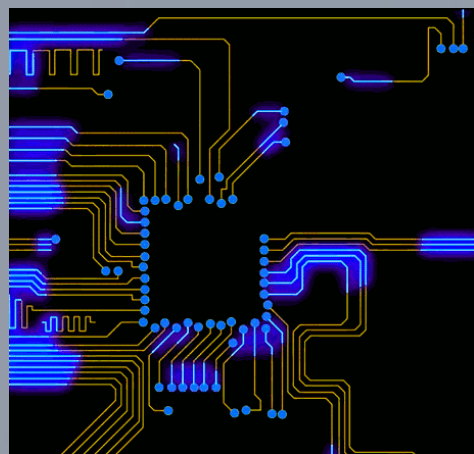


- Weaker signals
- VLSI and ULSI circuits
- Reduced shielding capabilities



INTRODUCTION: OVERVIEW

EMCS: Frameworks



INTRODUCTION: ORGANIZATION

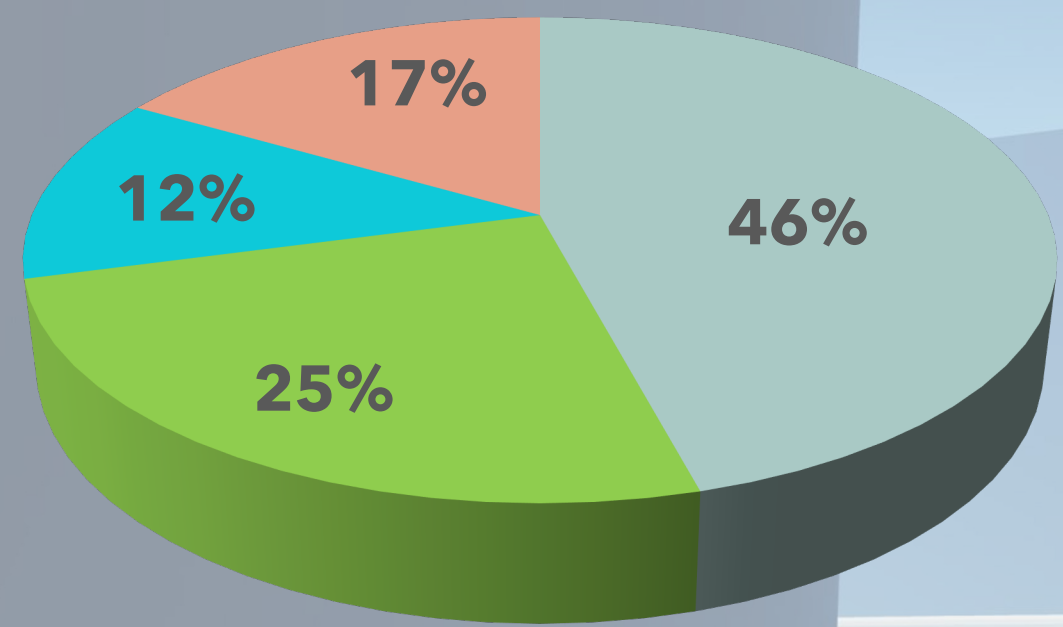
Main topics:

- ✓ Basics of EMC
- ✓ Frequency domain analysis
- ✓ Circuit models
- ✓ Radiated emissions and immunity
- ✓ Conducted emissions and immunity
- ✓ Crosstalk
- ✓ Filtering and shielding
- ✓ EMC measurement facilities
- ✓ EMI reduction methods
- ✓ Information leakage and EM security
- ✓ Human exposure to EM radiations
- ✓ Regulations and measurement standards

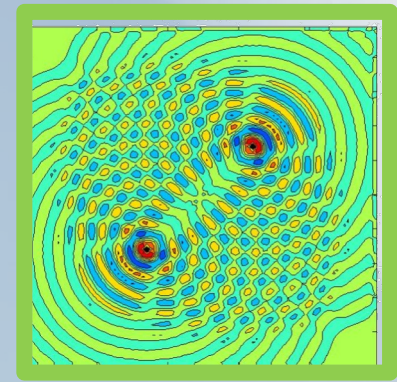


INTRODUCTION: ORGANIZATION

6 CFU – 48 hours



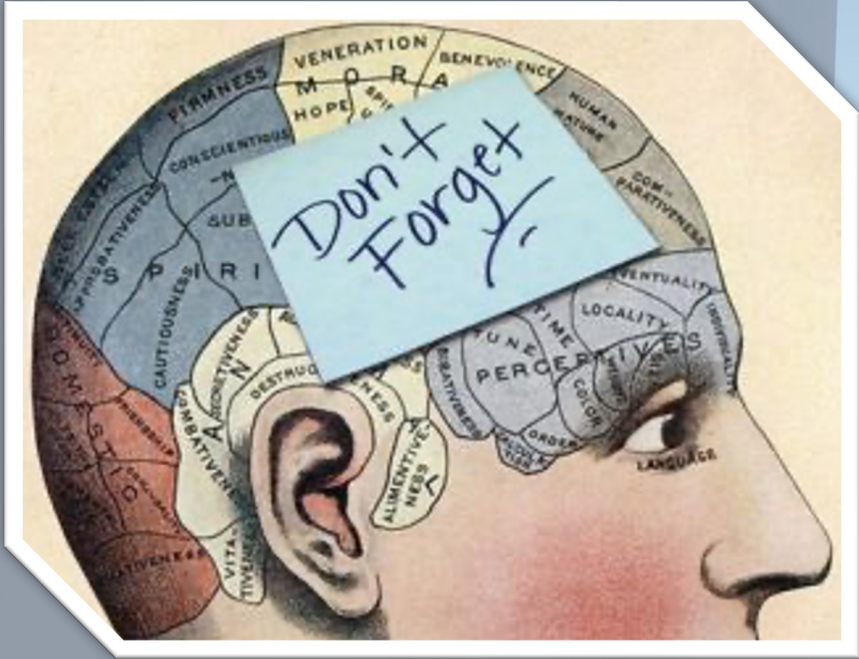
- Traditional lesson
- Guided exercise
- Technical seminar
- Lab experience



INTRODUCTION: ORGANIZATION

The following background is needed:

- **EM fields**
- **Antennas and propagation**
- **Circuit theory**
- **Digital and analog electronics**
- **Signal theory**
- **Analysis in the frequency domain**

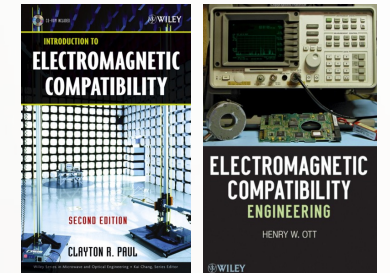


INTRODUCTION: ORGANIZATION

- **Timetable: Monday, room 9, 16:18**
Thursday, computer room 3, 14:16



- **Material: Slides (e-learning)**
Suggested textbooks



- **Contacts: andrea.buono@uniparthenope.it**
MS teams



- **Exam: Oral interview**



INTRODUCTION: ORGANIZATION

At the end of the course....



INTRODUCTION: ORGANIZATION

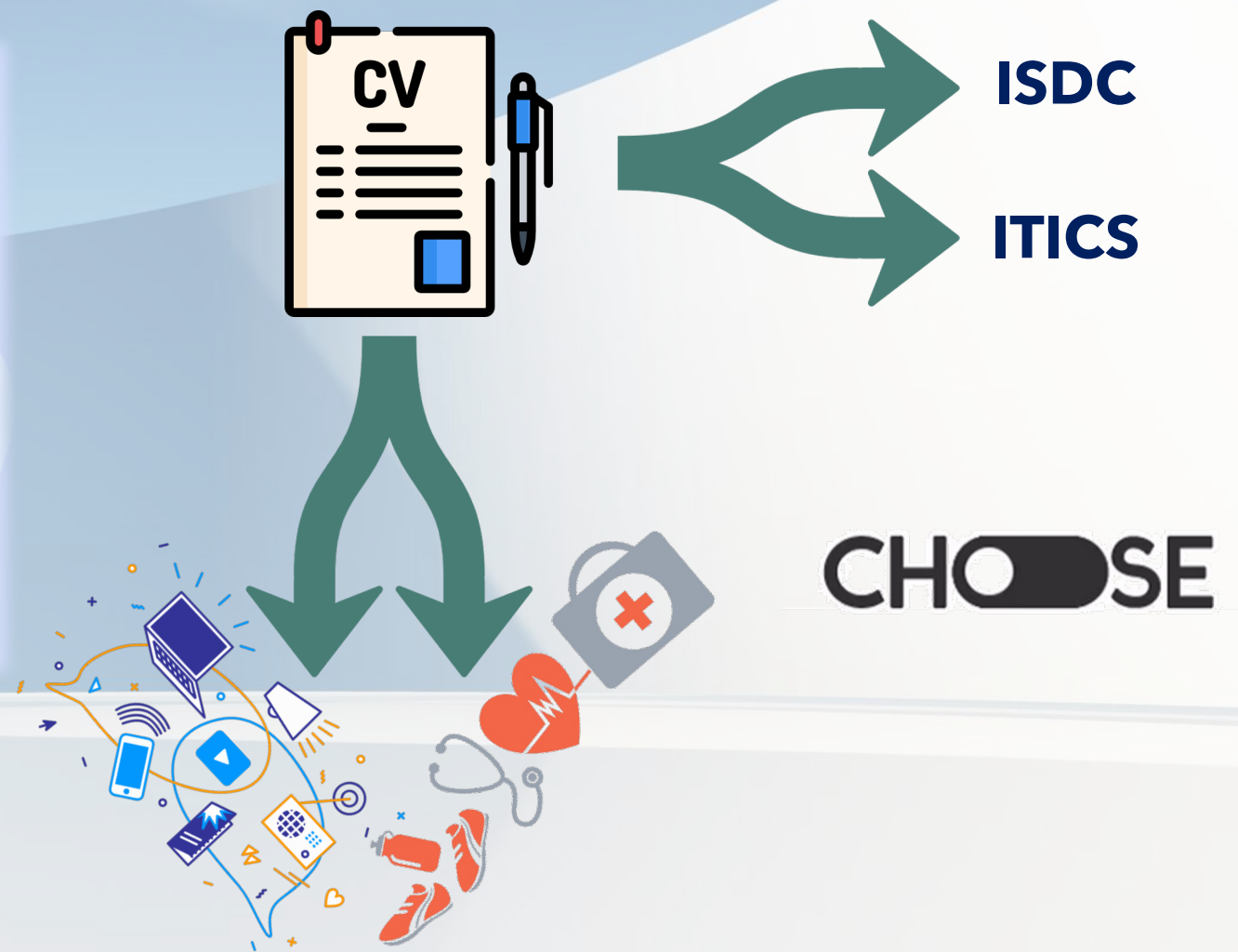
At the end of the course....

- **Automotive**
- **Aerospace**
- **Bioengineering**
- **Embedded systems**
- **Media**
- **Security**
- **Sensor networks**
- **TLC**
- **.....**

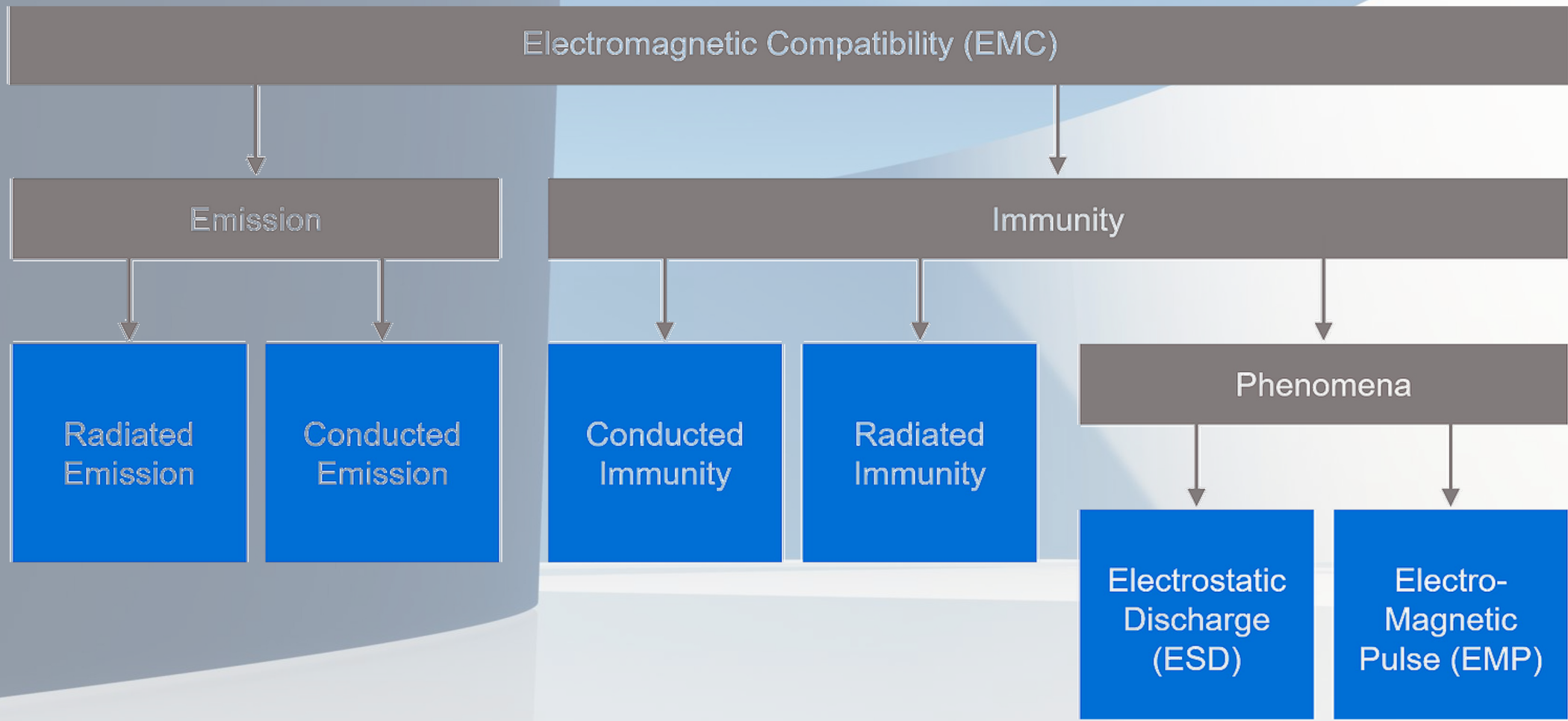


INTRODUCTION: AUDIENCE

Introduce yourself



INTRODUCTION: BASICS



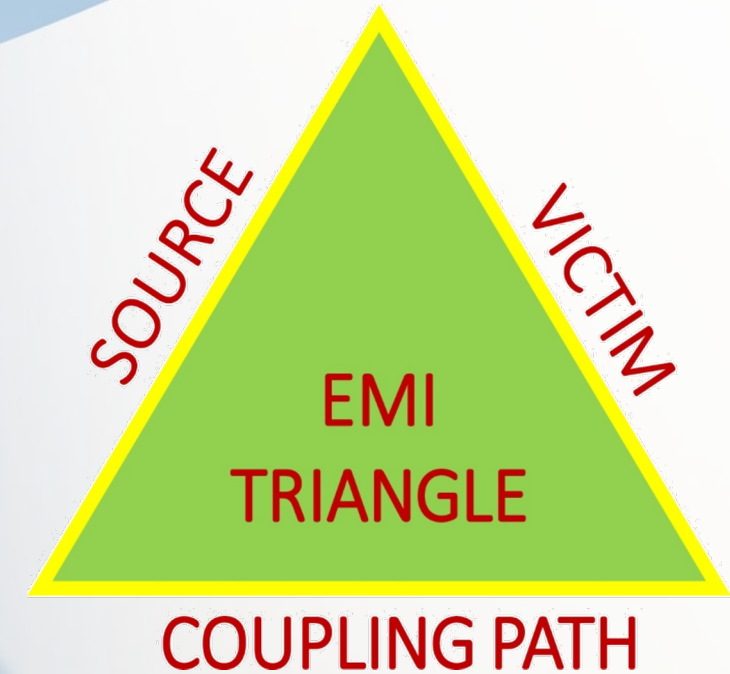
INTRODUCTION: BASICS

Electromagnetic Compatibility (EMC)

The discipline that aims at ensuring that all the electronic components/subsystems regularly work together in any electromagnetic environment

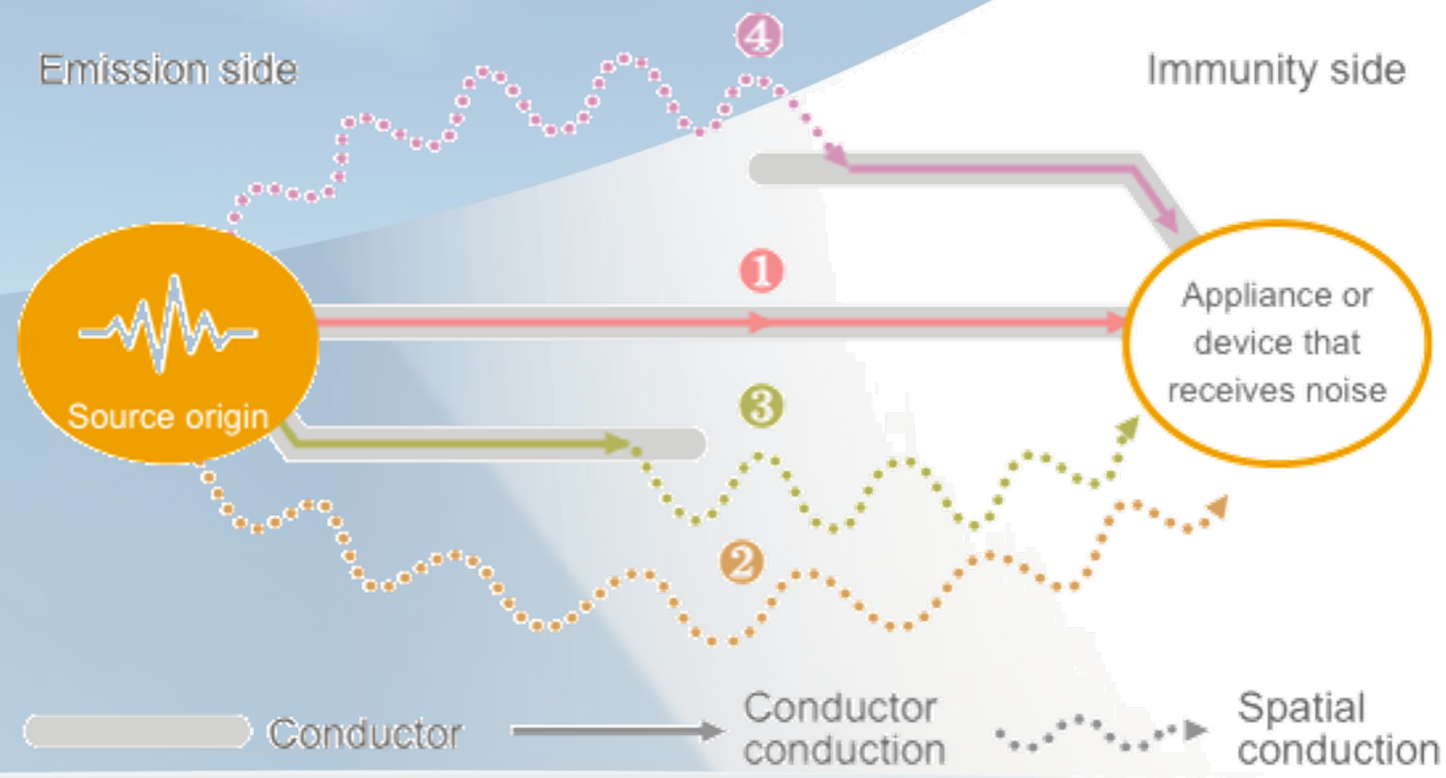
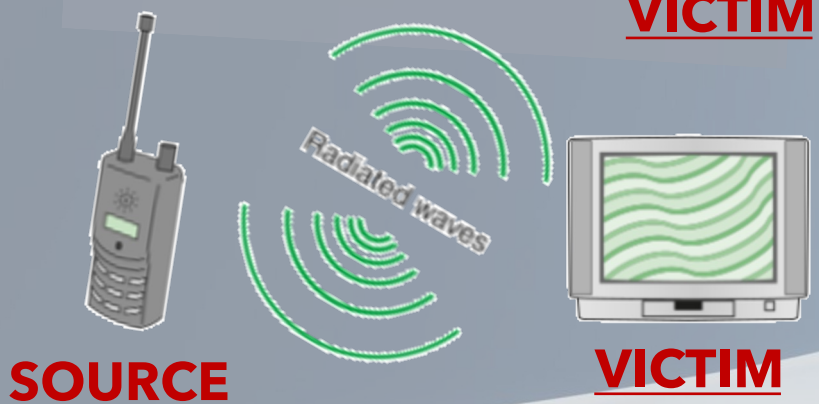
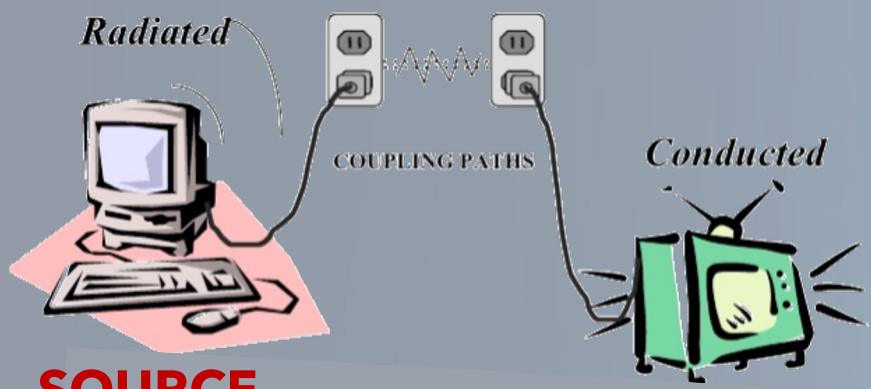
Electromagnetic Interference (EMI):

Undesired interaction among components/subsystems under their standard working conditions due to the propagation of electromagnetic energy



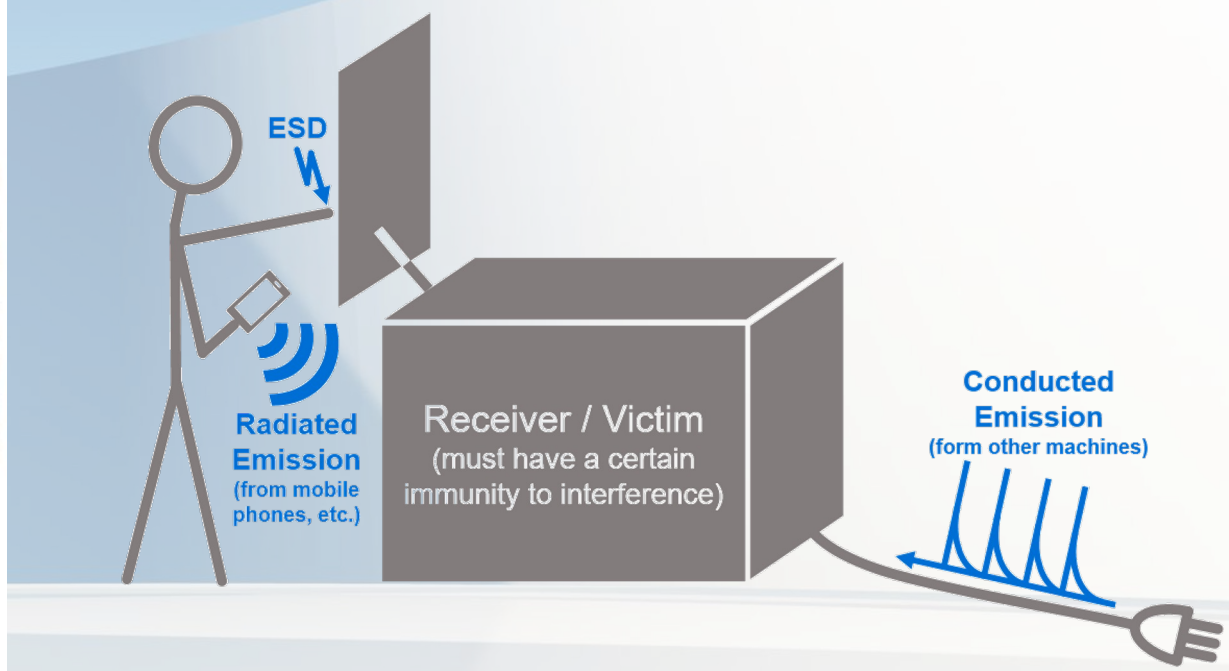
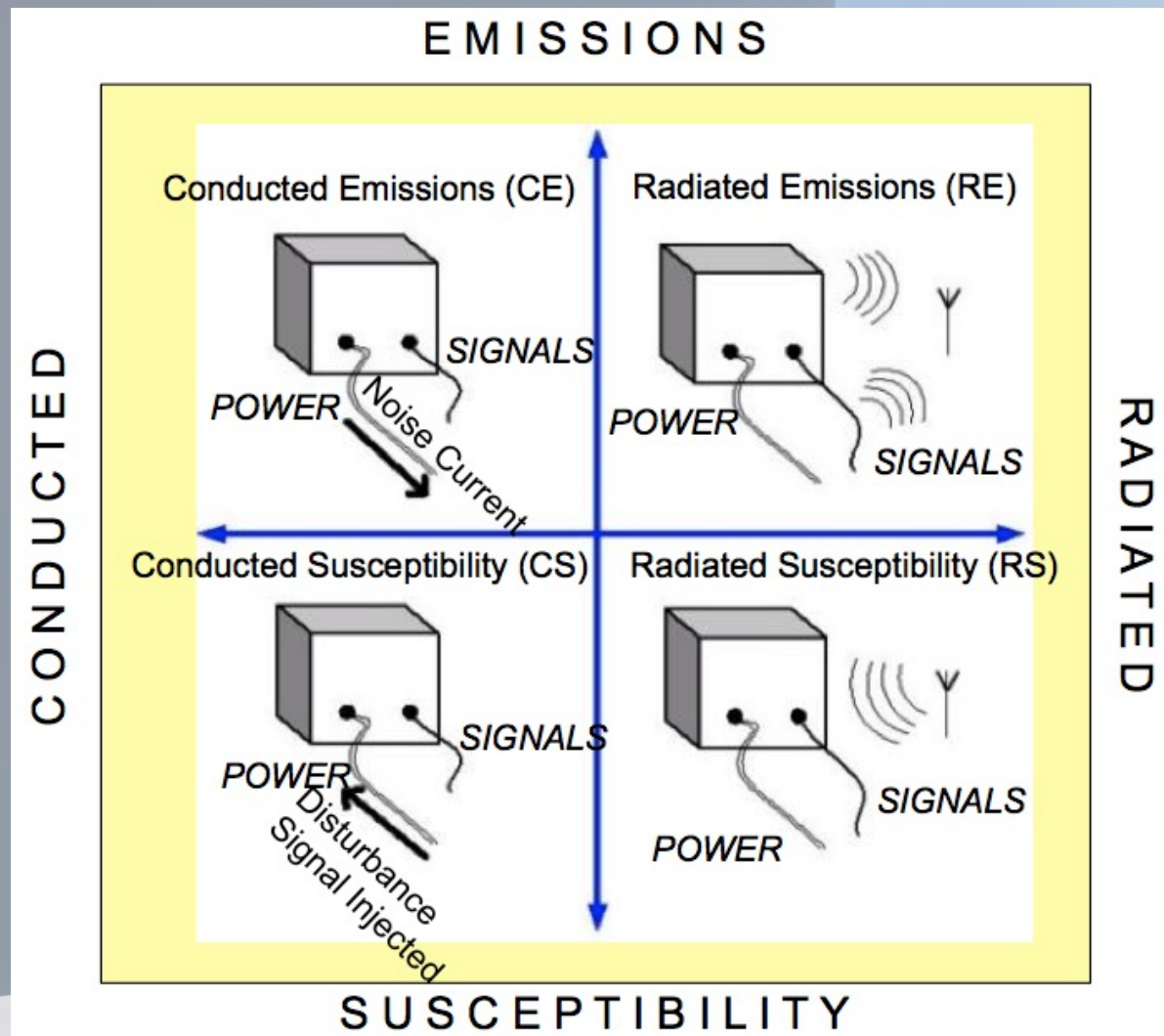
INTRODUCTION: BASICS

COUPLING PATH



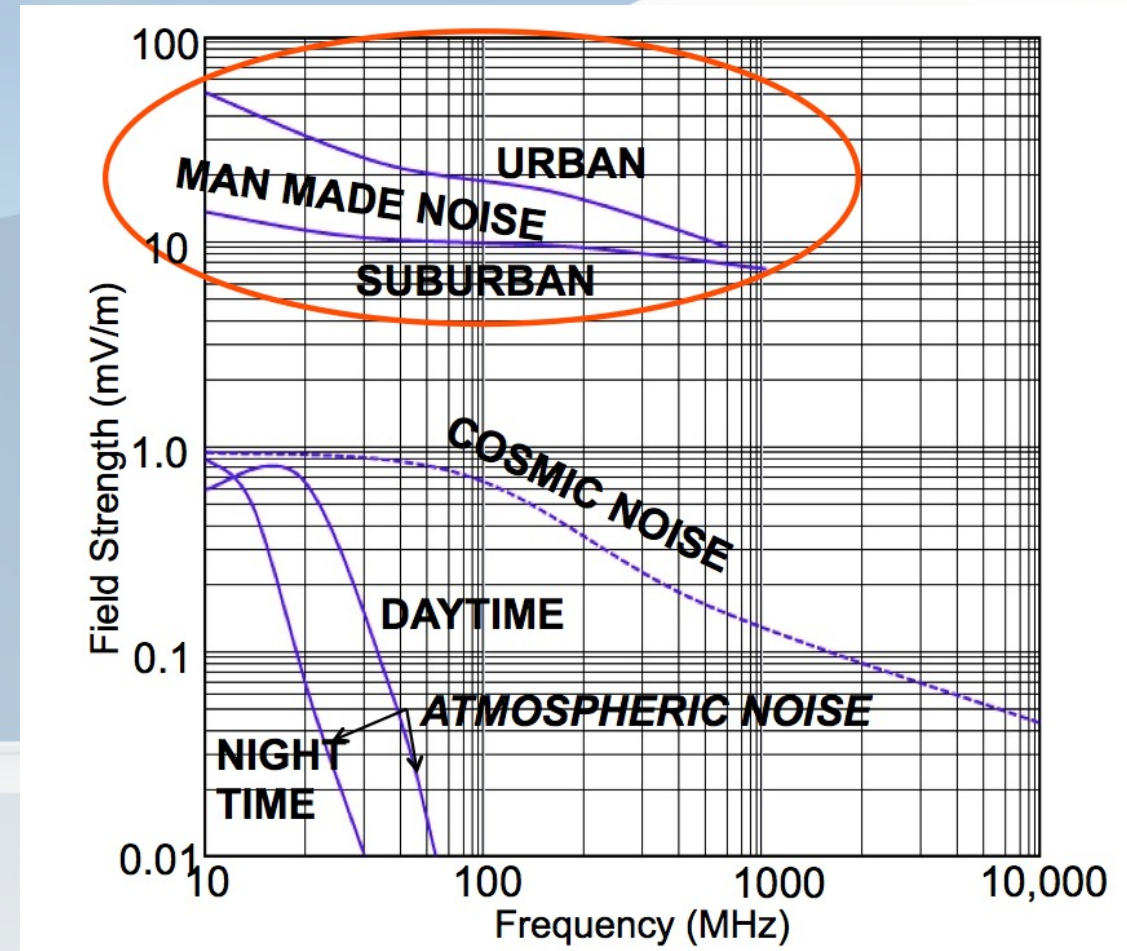
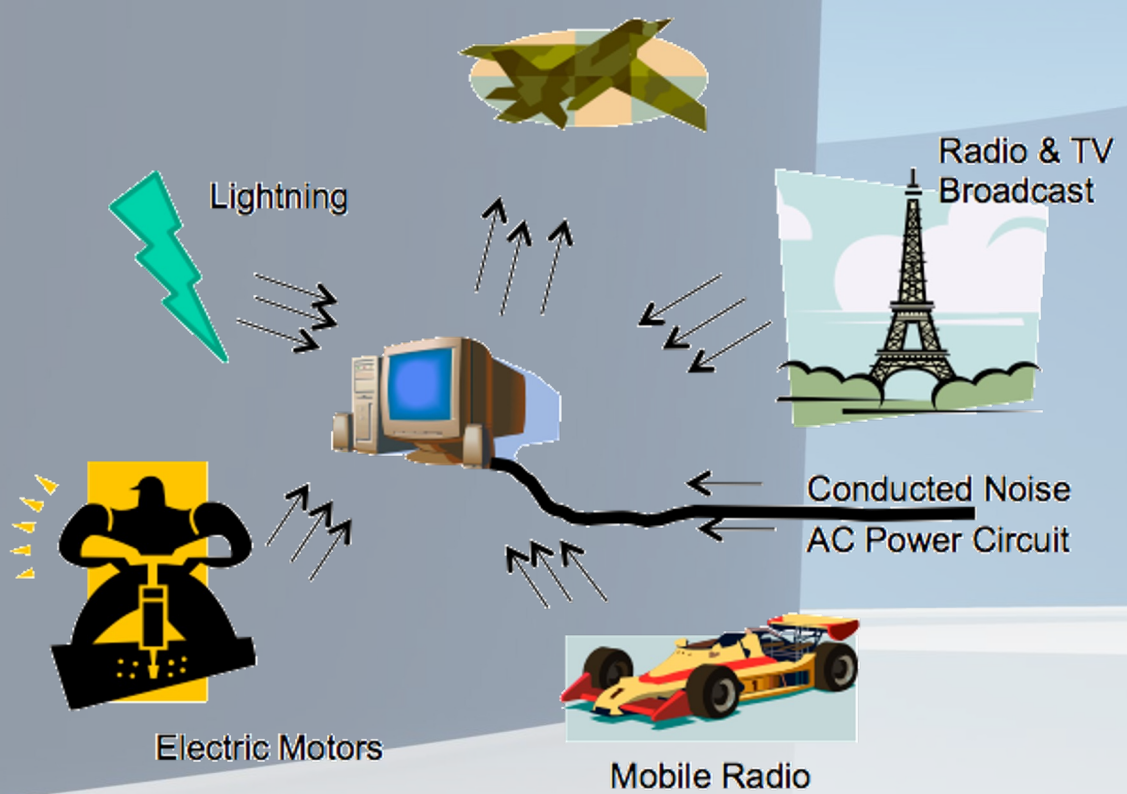
- 1 Conductor conduction
- 2 Spatial conduction
- 3 Conductor conduction → Spatial conduction
- 4 Spatial conduction → Conductor conduction

INTRODUCTION: BASICS



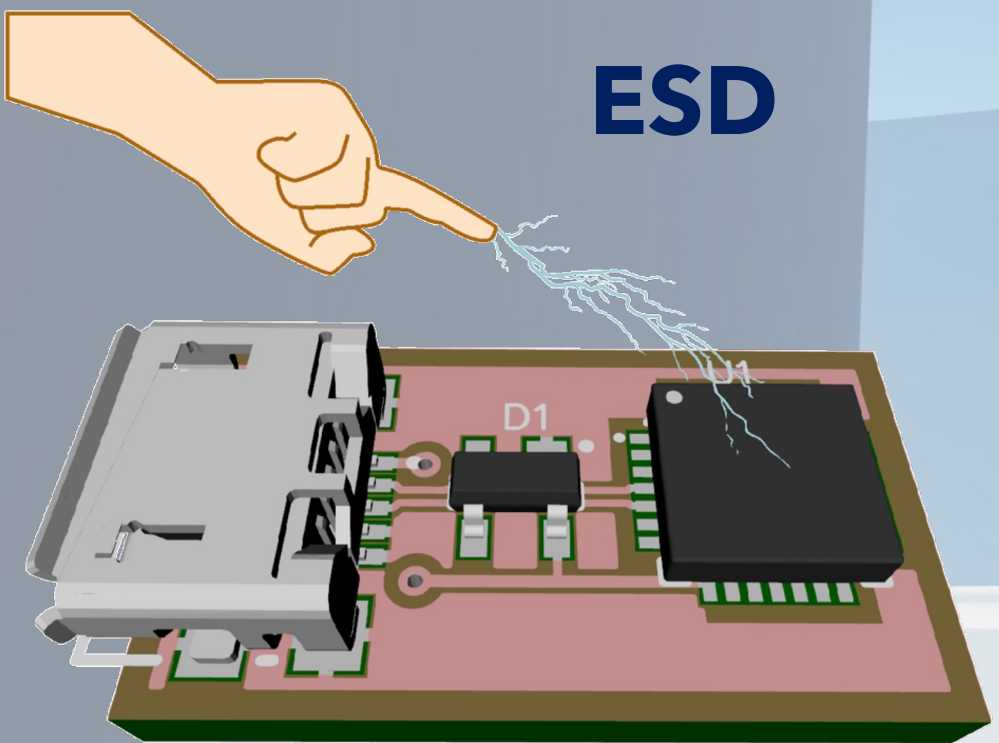
INTRODUCTION: BASICS

Man-made and natural processes:

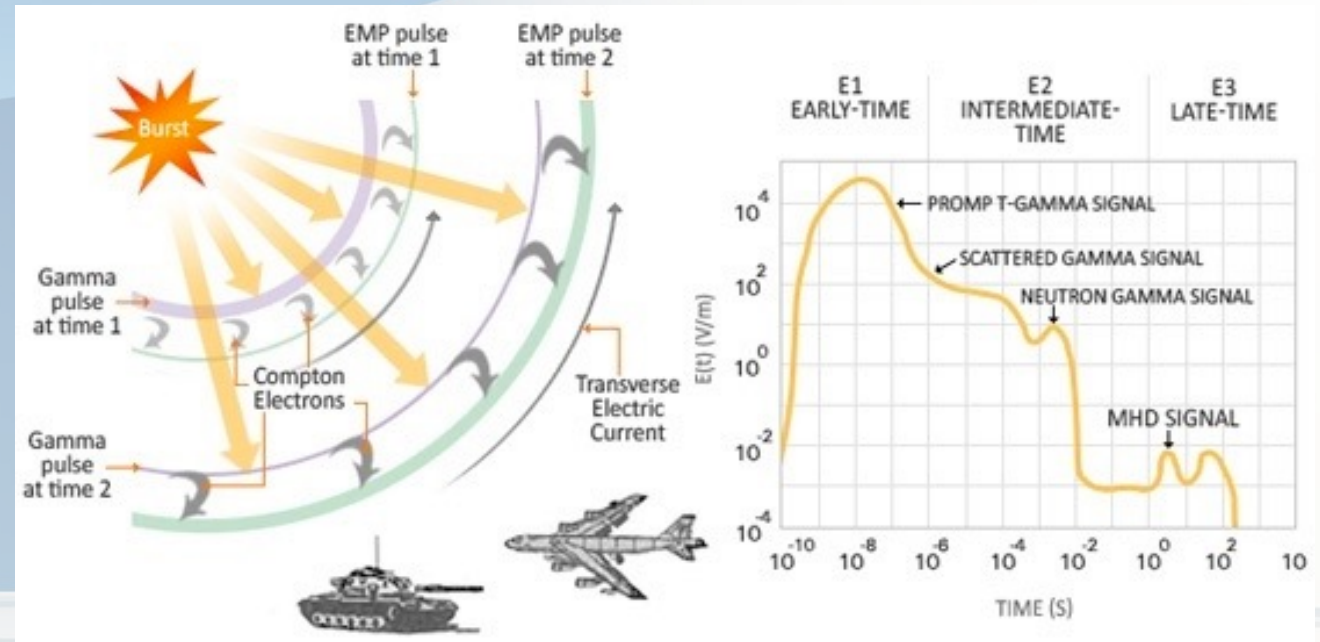


INTRODUCTION: BASICS

Further processes:



ESD



EMP

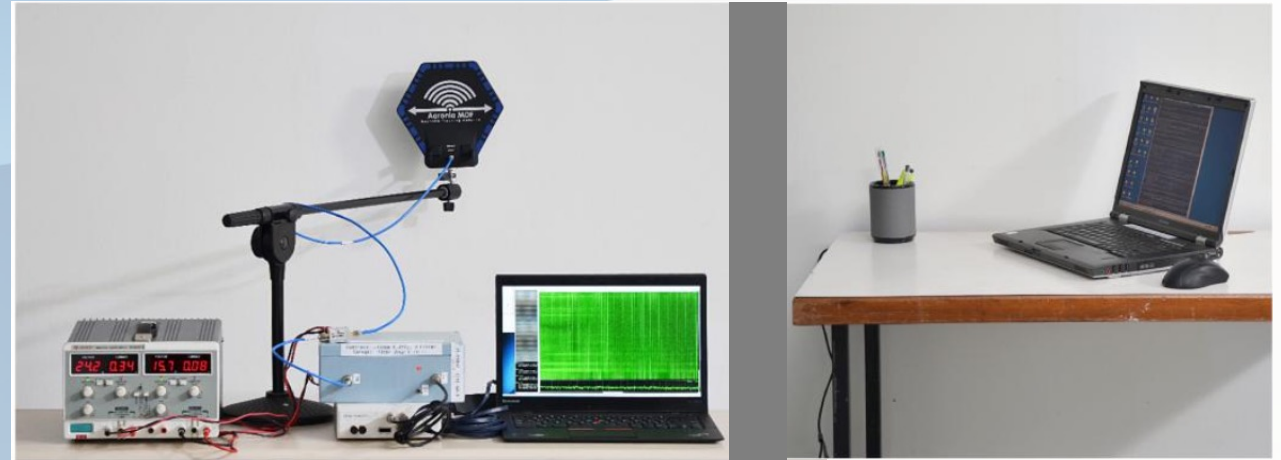
INTRODUCTION: BASICS

Further processes:



LIGHTNING

INFORMATION LEAKAGE



INTRODUCTION: BASICS

Standards and regulations

MODELS

*Power supplies
EM attacks
Crosstalk
Radiated emissions
Coupling mechanisms
Circuit passive components
Radiated immunity
Electrostatic discharge*

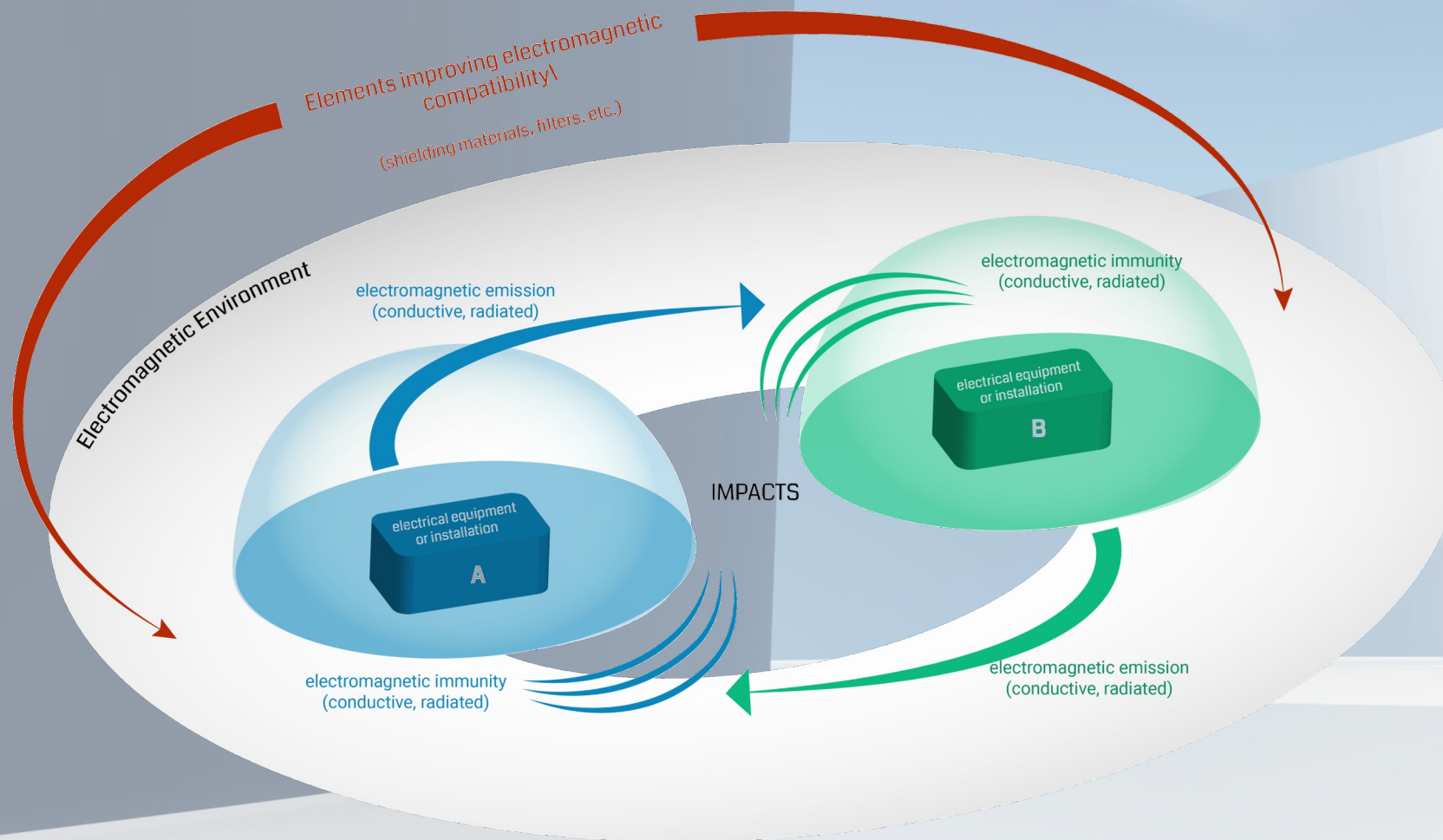
MEASUREMENTS

*EMC facilities
Spectrum analyzer
Dosimetry
Shielding effectiveness
Line impedance stabilization network
Current probes
Specific absorption rate*

REMEDIATIONS

*Ferrite beads
Chokes
Shielded wires
Power supply filters
EMC-driven smart planning
EM shields*

INTRODUCTION: BASICS

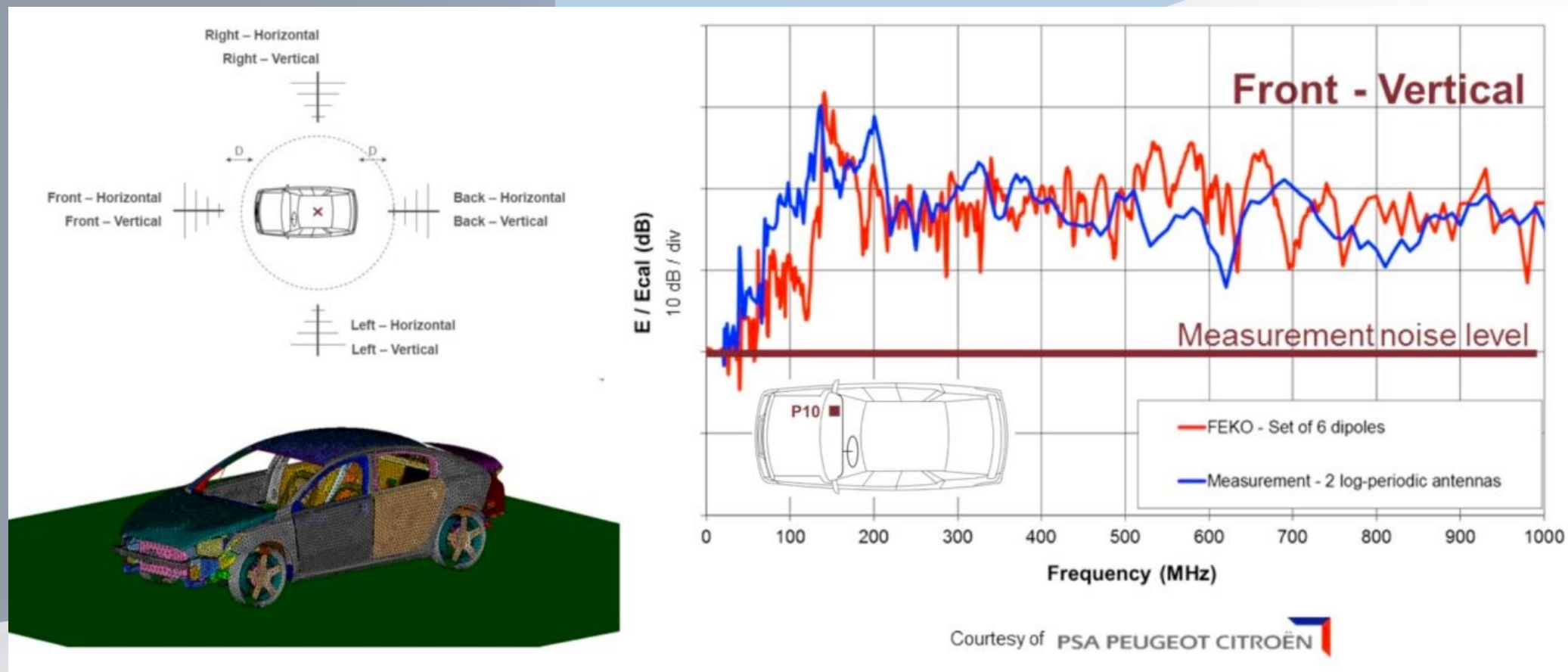


STANDARDS & REGULATIONS

- **MODELS**
- **MEASUREMENTS**
- **REMEDIATIONS**

INTRODUCTION: BASICS

Showcase: AUTOMOTIVE



INTRODUCTION: BASICS

Showcase: EM INFORMATION SECURITY



INTRODUCTION: BASICS

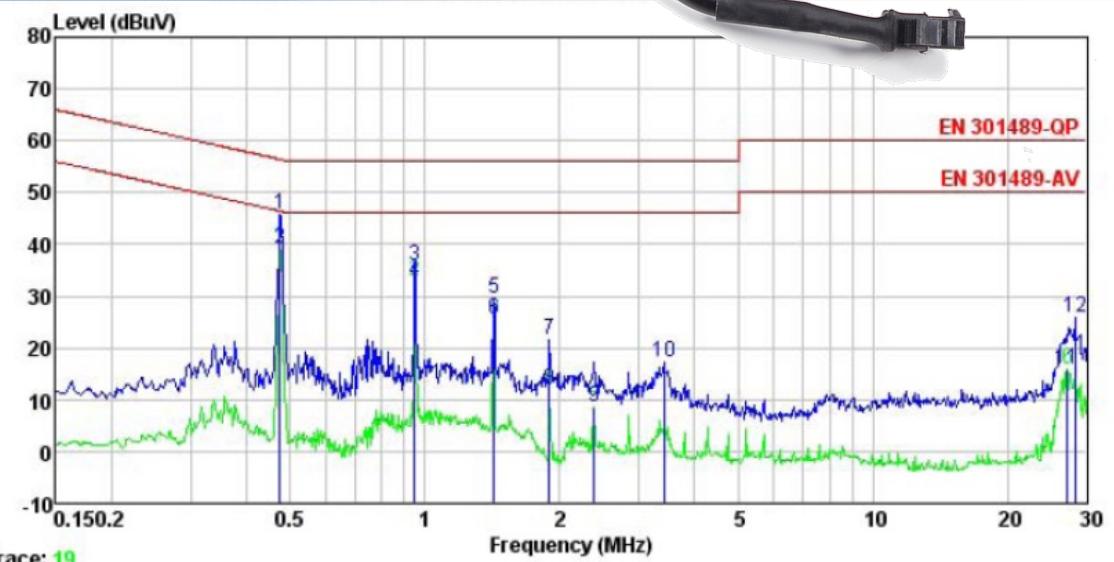
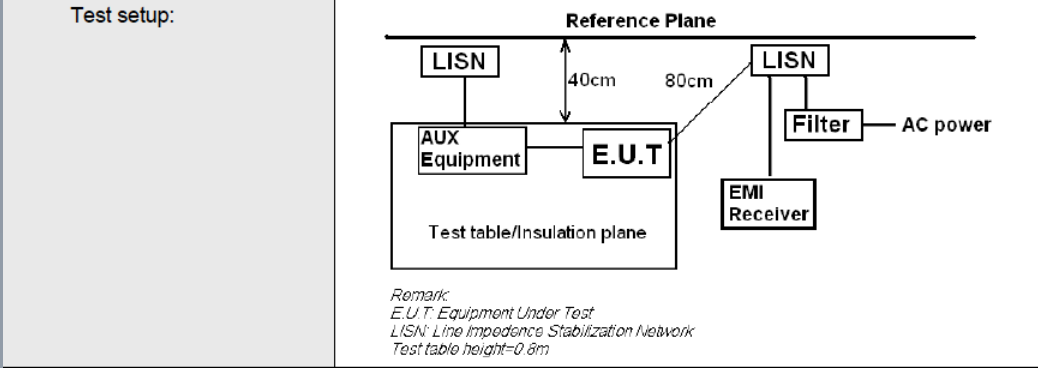
Showcase: TLC

Report No: CCIS13070022502

6.2.2 Conducted Emission

Test Requirement:	ETSI EN 301 489-3		
Test Method:	ETSI EN 301 489-1		
Test Frequency Range:	150kHz to 30MHz		
Class / Severity:	Class B		
Receiver setup:	RBW=9KHz, VBW=30KHz		
Limit:	Frequency range (MHz)	Limit (dBuV)	
		Quasi-peak	Average
	0.15-0.5	66 to 56*	56 to 46*
	0.5-5	56	46
	5-30	60	50

* Decreases with the logarithm of the frequency.



Trace: 19
Site : CCIS Conducted test Site
Condition : EN 301489-QP LISN
Job. no : 225RF
Test Mode : GPS mode
Power Rating : DC 12V
Environment : Temp: 23 °C Humi:56% Atmos:101KPa

INTRODUCTION: BASICS

Showcase: Human exposure

